

Elementi elektronike – FEBRUAR 2018 – REŠENJA

3.

DC analiza:

$$V_I = V_{D2} + V_{R2} = V_{D2} + R_2 I_{R2}$$

$$I_G = I_{D1} + I_{R1} = \frac{V_X - V_{D1}}{R_3} + \frac{V_X - V_{D2}}{R_1 + R_2}$$

$$V_X = I_G \frac{R_3(R_1 + R_2)}{R_1 + R_2 + R_3} + V_D$$

$$I_{R1} = I_{R2} = \frac{V_X - V_{D2}}{R_1 + R_2} = 5 \text{ mA}$$

$$V_I = V_{D2} + V_{R2} = V_{D2} + R_2 I_{R2} = 0.8 \text{ V}$$

AC analiza:

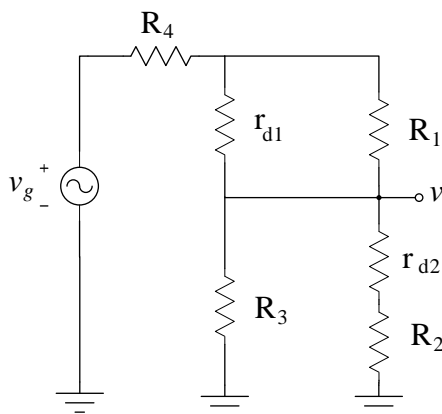
$$r_{d1} = \frac{V_I}{I_{D1}} = 5 \Omega$$

$$r_{d2} = \frac{V_I}{I_{D2}} = 5 \Omega$$

$$V_i = \frac{\frac{R_3(R_2 + r_{d2})}{R_3 + R_2 + r_{d2}}}{\frac{R_3(R_2 + r_{d2})}{R_3 + R_2 + r_{d2}} + \frac{R_1 \cdot r_{d1}}{R_1 + r_{d1}} + R_4} V_g = 26.772 \text{ mV}$$

$$v_i = V_i \sin(\omega t)$$

Ukupni signal je jednak $v_I = V_I + v_i$.

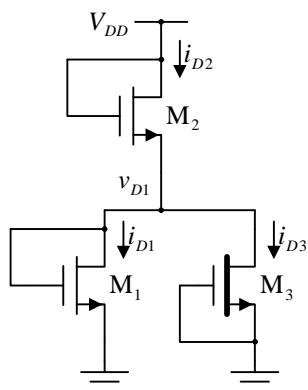


Slika 2

4.

Tranzistor M_3 je sa ugrađenim kanalom, tako da provodi i pri $v_{GS3} = 0$. Pod pretpostavkom da tranzistor M_3 radi u režimu zasićenja važi

$$I_{D3} = \frac{k_n}{2} (V_{GS3} - V_{t3})^2 = \frac{k_n}{2} V_t^2 = 500 \mu\text{A}.$$



Na osnovu slike se može pisati

$$V_{GS1} + V_{GS2} = V_{DD},$$

iz čega sledi

$$V_t + \sqrt{\frac{2I_{D1}}{k_n}} + V_t + \sqrt{\frac{2I_{D2}}{k_n}} = V_{DD}.$$

Na osnovu slike se vidi da važi

$$I_{D2} = I_{D1} + I_{D3},$$

Na osnovu čega se prethodni izraz transformiše u

$$V_t + \sqrt{\frac{2I_{D1}}{k_n}} + V_t + \sqrt{\frac{2(I_{D1} + I_{D3})}{k_n}} = V_{DD}.$$

Rešavanjem prethodne jednačine dobija se

$$I_{D1} = \frac{k_n}{8} \left(\frac{V_t^2 - (V_{DD} - 2V_t)^2}{V_{DD} - 2V_t} \right)^2 = \frac{8}{9} \text{ mA},$$

$$V_{D1} = V_{GS1} = V_t + \sqrt{\frac{2I_{D1}}{k_n}} = \frac{7}{3} \text{ V},$$

$$I_{D2} = \frac{k_n}{2} (V_{DD} - V_{D1} - V_t)^2 = \frac{25}{18} \text{ mA}.$$

S obzirom da su ispunjeni uslovi

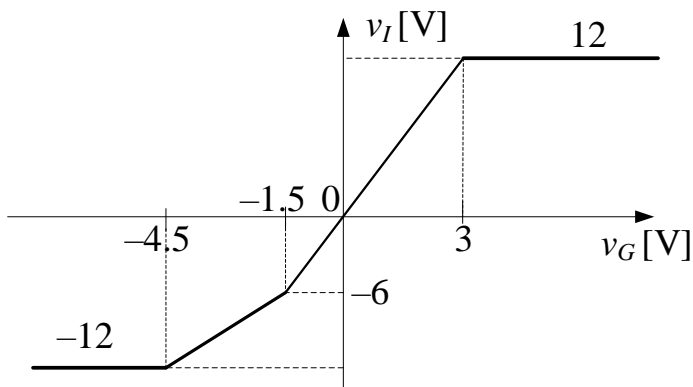
$$V_{DS3} \geq V_{GS3} - V_{t3},$$

$$V_{D1} \geq V_t,$$

tranzistor M_3 zaista provodi u režimu zasićenja. Ovu proveru nije potrebno raditi za preostala dva tranzistora jer su kod njih gejti i drejni kratko spojeni, tako da uvek rade u zasićenju ($V_{GD} = 0 < V_t$).

7.

$$v_I = \begin{cases} -12\text{V} & v_G < -4.5\text{V} & \text{OP neg. zas.} \\ 2v_G - 3\text{V} & -4.5\text{V} \leq v_G < -1.5\text{V} & \text{D on} \\ 4v_G & -1.5\text{V} \leq v_G < 3\text{V} & \text{D off} \\ 12\text{V} & v_G \geq 3\text{V} & \text{OP poz. zas.} \end{cases}$$

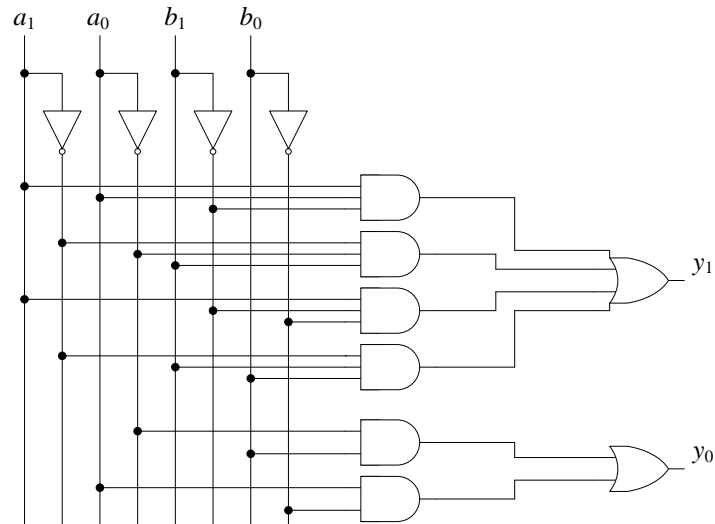
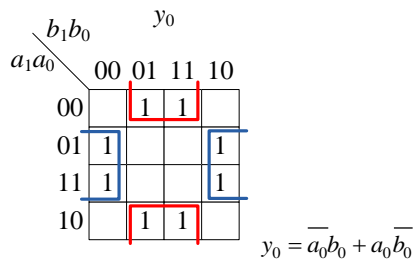
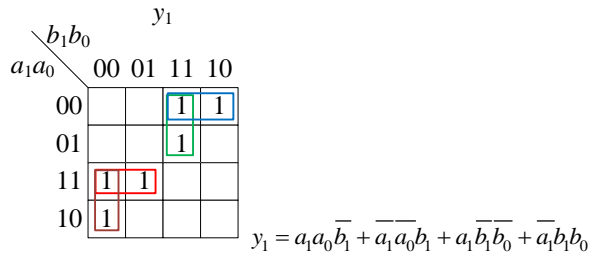


8.

a_1	a_0	b_1	b_0	y_1	y_0
0	0	0	0	0	0
0	0	0	1	0	1
0	0	1	0	1	0
0	0	1	1	1	1
0	1	0	0	0	1
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	1	0
1	0	0	0	1	0
1	0	0	1	0	1
1	0	1	0	0	0

1	0	1	1	0	1
1	1	0	0	1	1
1	1	0	1	1	0
1	1	1	0	0	1
1	1	1	1	0	0

b)

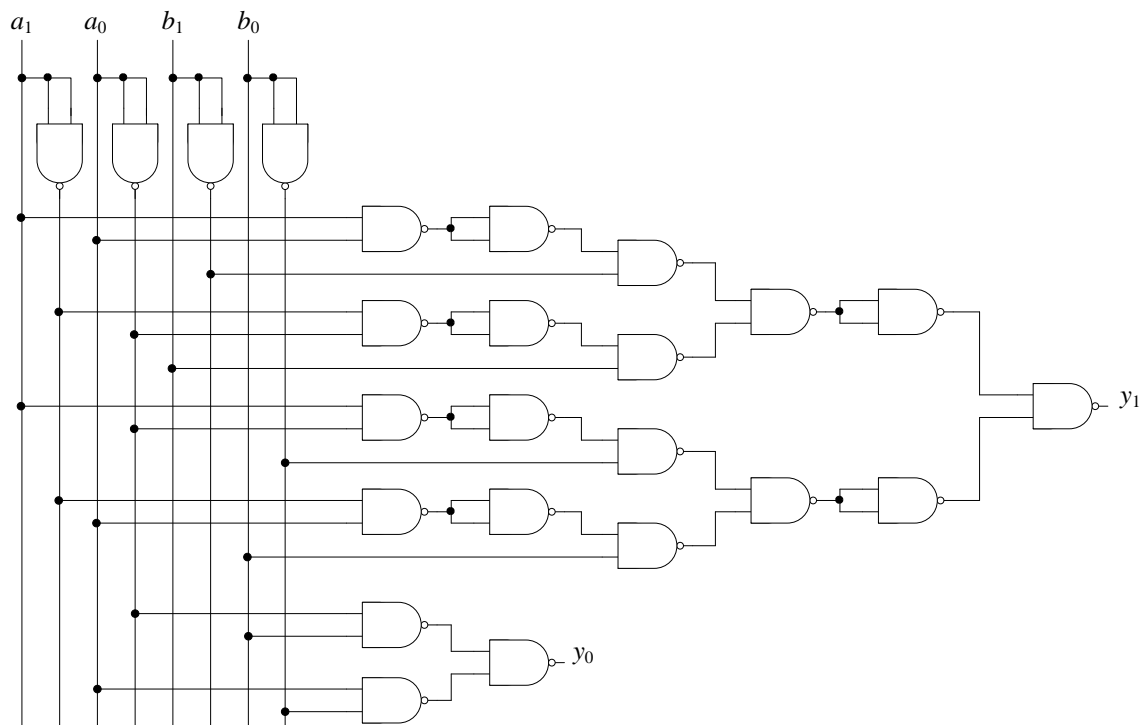


c) Primenom DeMorganovih zakona i grupisanja po dva faktora logičke I operacije dobija se

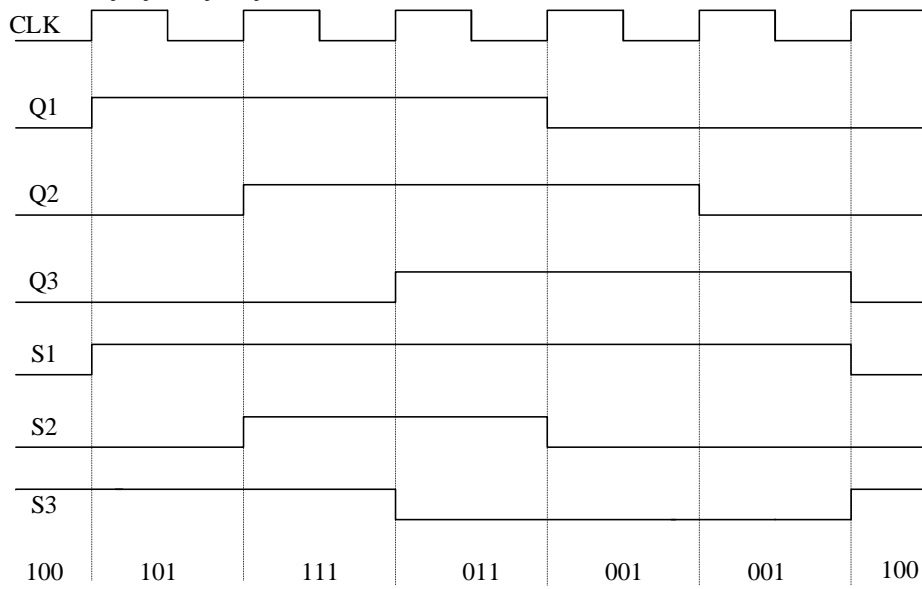
$$y_1 = a_1a_0\bar{b}_1 + a_1a_0b_1 + a_1\bar{b}_1b_0 + a_1b_1b_0 = \overline{\overline{a_1a_0\bar{b}_1} \cdot \overline{a_1a_0b_1}} \cdot \overline{\overline{a_1\bar{b}_1b_0} \cdot \overline{a_1b_1b_0}} = \overline{\overline{a_1a_0} \cdot \overline{b_1}} \cdot \overline{\overline{a_1a_0} \cdot \overline{b_1}} \cdot \overline{\overline{a_1\bar{b}_1} \cdot \overline{b_0}} \cdot \overline{\overline{a_1b_1} \cdot \overline{b_0}}$$

$$= \overline{\overline{a_1a_0} \cdot \overline{b_1}} \cdot \overline{\overline{a_1a_0} \cdot \overline{b_1}} \cdot \overline{\overline{a_1\bar{b}_1} \cdot \overline{b_0}} \cdot \overline{\overline{a_1b_1} \cdot \overline{b_0}}$$

$$y_0 = a_0b_0 + a_0\bar{b}_0 = \overline{\overline{a_0b_0} \cdot \overline{a_0\bar{b}_0}}$$



9.
Moduo brojanja brojača je 6.



Slika 2.